MEASURING PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN WORK-RELATED VIBRATION

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Introduction

Until now there has been controversy about which tests should be performed to diagnose early Hand-Arm Vibration Syndrome (HAVS). Initial screening questions, especially about tingling and numbness, routinely given to patients prior to examinations proved to be a very important tool in the diagnostic process[1, 4]. However, standardized tests that are simple, quick, valid and reliable are needed to support a diagnosis of HAVS. **Purpose:** To find the most valid and reliable tests to diagnose HAVS.

Material and Methods

Five major tests were performed on Group I and Group II. Group I: Control group of 12 volunteers including students, nurses, secretaries and physicians with no history of using vibrating tools (age 20 to 50y, mean age 38.5y; 5male, 5 female.) Group II: 12 workers (age 17 to 65y, mean age 39y; 9 male, 3 female) were sent by a local trade union with a history of using vibrating power tools on their jobs for varying amounts of time (mean 12.2y, from 0.5 to 35y.) Pre-enrollment survey showed that each had more than 4 complaints commonly associated with use of vibrating tools (including numbness, tingling, weakness, pain, finger color or nail changes, temperature change, and difficulty moving.)
1. Sensory nerve conductive tests: Amplitude and nerve conductive velocity (NCV) were evaluated. 2. Cold Stress-Temperature recovery time tests were done on the index finger of the dominant hand following these steps: Confirm water bath is within 4-5º C. Place the finger temperature probe on pad of the index finger of the dominant hand. Record temperature every 15 seconds. Place subject's hand in the cold- water bath for exactly five minutes. Record temperature every 15 seconds for ten minutes. 3. Blood test: Venous blood was taken by a 21-gauge needle with the yellow collection tube adapter. S-ICAM, Sera Thrombomodulin, Norepinephrine levels were evaluated by Henderson Research Centre, Canada. 4. Finger Sensory Evaluation: Semmes-Weinstein monofilament test and 2-point discrimination tests were performed on bilateral fingers. 5. Digital blood pressure test: blood pressure was measured in bilateral index fingers.

Results

1. Median nerve sensory conductive amplitude from palm to wrist :
   GI: mean 96 ± 31μm; GII: mean 43± 30μm; for dominant hands.

   GI vs GII: $P<0.001$

Motor nerve conductive velocity (NCV) from elbow to wrist:

GI: mean 60.8± 8.5m/s; GII: mean 48.3± 5.9m/s; GI vs GII: $P<0.001$

2. Cold-Stress Test: Temperature Recovery Rate (TRR) = T before test / T after 10 minutes. GI: mean: 85.36% ± 14.22 GII: More three years of using vibrating tools was a critical point, with vibration for 3 years, the TRR was 70% and as time of use increased, the correlation to TRR also increased. Two subjects' TRR was 52% with 15 and 35 years of using vibrating tools.

3. Sera Chemical Test: A. sICAM: Standard Reference Range is 132.5-344.2ng/mL. GII: The value of 3 workers > 344.2ng/mL (385.2, 346.4 and 381.4), Positive rate was 25.0%; B. Norepinephrine: Standard Reference Range is 0.8-3.4; 4 workers' value was <0.8 nmol/L (0.5, 0.7, 0.3, 0.6). Positive rate was 33.3%.

4. Hand Sensory Evaluation:
   A. Semmes-Weinstein monofilament test: Standard criterion: Normal: 1.65-2.83; Diminished light touch: 3.22-3.61; Diminished protective sensation: 3.84-4.31; Loss of protective sensation: 4.59-6.65.
   Results: 3 workers (3.5years) were normal; 9 workers (>5 years) were diminished. Positive rate was 66.98%.
   B. Two-point discrimination test: Normal is < 6mm. GI: 119/120 tested fingers were less than 6 mm; GII: 20/120 were < 6mm. Positive rate was 16.7 %.
5. Digital blood pressure test: Normal cut-off point: < 70 mmHg was abnormal. Results: GI: none was < 70; GII: 8/23 fingers (n=23, index fingers in both hands, 1 n/a); positive rate was 35%.

Conclusions

1. Semmes-Weinstein monofilament test is a sensitive and simple test to assess HAVS. 2. Cold stress test gave a lower positive rate but did indicate later damage; however, it causes patient discomfort.3. Sensory nerve conductive and NCV were useful but need a control group value.4. The S-ICAM increased in 25%, and NE decreased in 33% of vibrated workers. 5. Digital BP test and 2-point discrimination test both have cut-off point value; they could be used to differentiate HAVS from simple carpal tunnel syndrome.

References

1. Cederlund R, Iwarsson S, Lundborg G. Hand function tests and questions on hand symptoms as related to the Stockholm workshop scales for diagnosis of hand-arm vibration syndrome. J Hand Surg [Br]. 2003 Apr;28(2):165-171.
2. Coughlin PA, Chetter IC, Kent PJ, Kester RC. The analysis of sensitivity, specificity, positive predictive value and negative predictive value of cold provocation thermography in the objective diagnosis of the hand-arm vibration syndrome. Occup Med (Lond). 2001 Mar;51(2):75-80.
3. Coughlin PA, Bonser R, Turton EP, Kent PJ, Kester RCA comparison between two methods of aesthesiometric assessment in patients with hand-arm vibration syndrome. Occup Med (Lond). 2001 Jun;51(4):272-277.
4. Elms J, Poole K, Mason H. A screening questionnaire for HAVS? Occup Med (Lond). 2005 Mar;55(2):139-141.